

# Health Effects of Diesel Emissions

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# Presentation Objectives

- Describe the most important constituents of diesel exhaust
- Characterize the chief health effects related to diesel emissions

# Diesel Exhaust Emissions

- Highly complex mixtures
  - Organic and inorganic compounds
  - Gaseous and particulate components
  - Compounds adsorbed to particle surfaces



# Gaseous Components

- Carbon monoxide
- Nitrogen and sulfur oxides
- Hydrocarbons:
  - Aldehydes
  - Benzene
  - 1,3-Butadiene
  - Polycyclic aromatic hydrocarbons (PAHs)

# Diesel Particulate Matter (DPM)

- Composition is dependent on several factors:
  - Engine type (e.g., “on road” vs. “off road”)
  - Operating conditions
  - Fuel and oil type
  - Presence of emissions controls

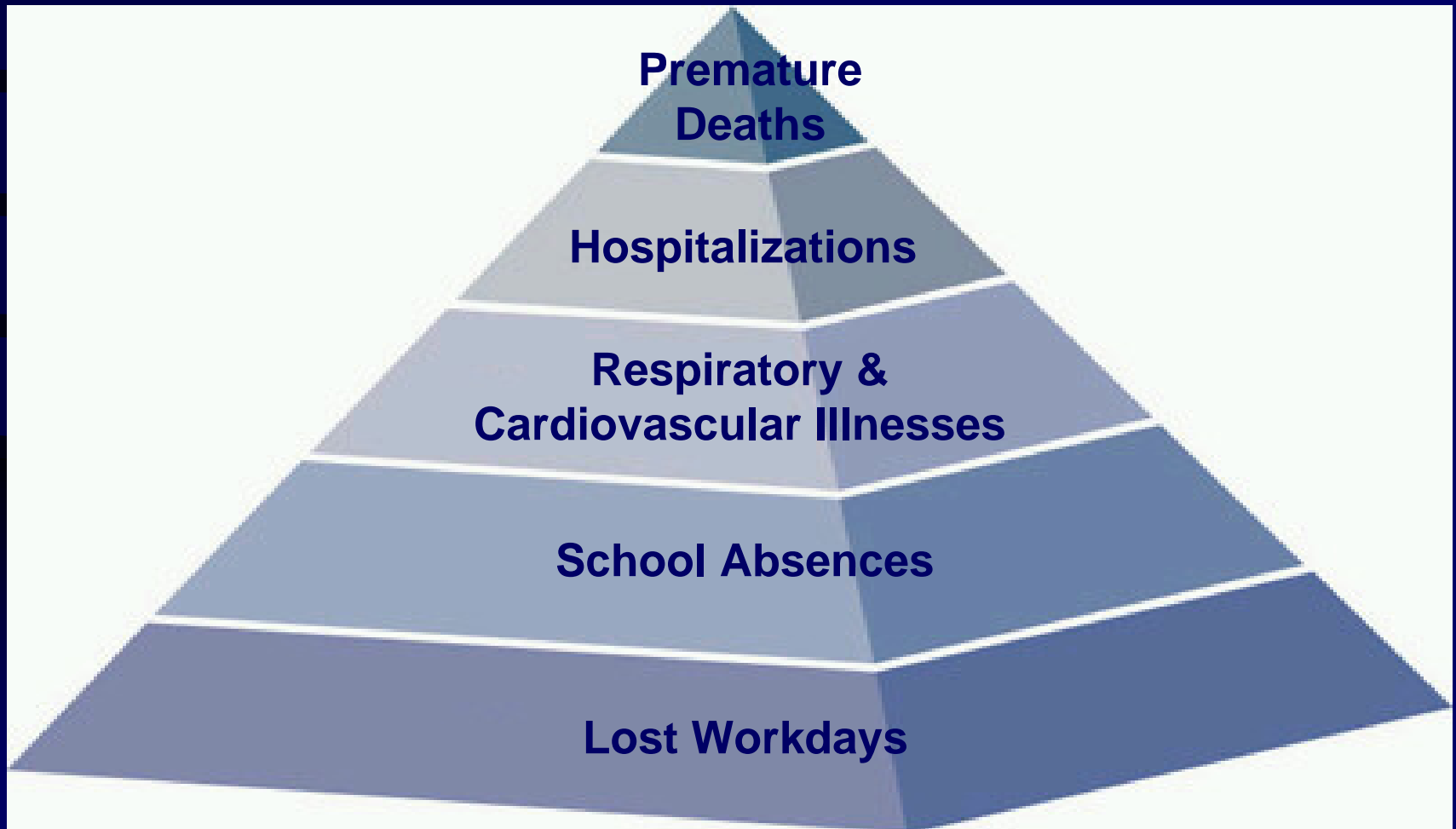
# Diesel Particulate Matter (DPM)

- Largely organic in nature
- Can be directly emitted or formed from gaseous emissions
- Primarily fine particles ( $< 2.5 \mu\text{m}$ ), with some ultrafine particles ( $< 0.1 \mu\text{m}$ )
- Adsorbed organic compounds include PAHs and their derivatives

# Diesel Emissions and Fine Particles

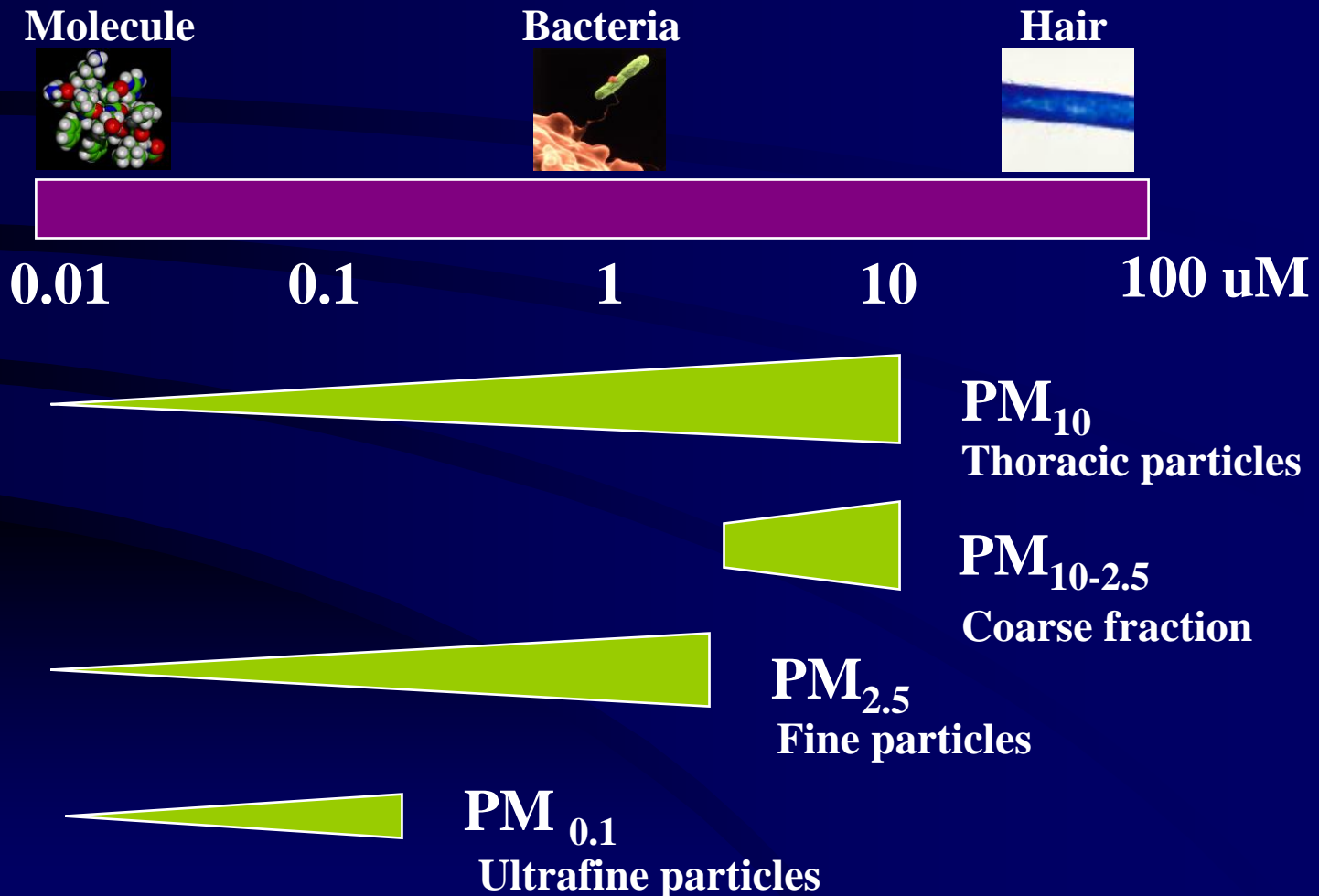
- DPM constitutes most of the health-relevant emission fraction
- Fine particles have greater surface area
  - Greater capacity for adsorbed organics
  - Better able to reach the gas exchange region of the lung
  - Represent some fraction of total particulate inventory (from 6 – 30%)

# Health Impacts of PM





# Particle Size Distribution

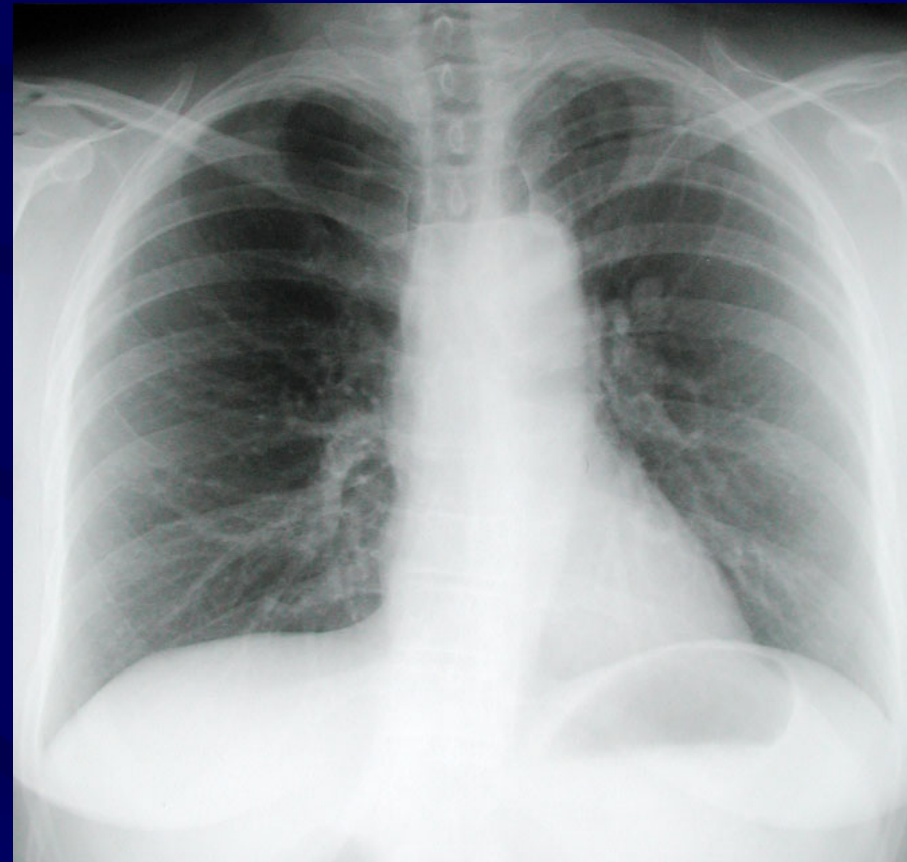


Source: Brook et al., 2004

# PM and Health

## Epidemiological Studies

- Key endpoints:
  - Decrements in pulmonary function
  - Respiratory symptoms
  - Hospital and emergency room admissions
  - Human mortality



# Sensitive Populations



- Children
- Elderly
- Individuals with Chronic Respiratory Disease
  - Asthma
  - Chronic Obstructive Pulmonary Disease
  - Bronchitis
  - Emphysema

# PM and Mortality

- Epidemiological link established between PM levels and daily mortality
  - Often by comparing aggregate health and environmental data
  - Fine particulate (PM<sub>2.5</sub>) contributes more greatly to increases in mortality

# PM and Cardiovascular Effects

- Daily hospital admissions for CVD higher on high PM days
  - Effect of other pollutants not established
- Decreased heart rate variability, risk of all myocardial infarction (fatal & non-fatal)

# PM and Respiratory Health Events

- Increased rate of hospital admission seen with  $PM_{10}$  exposure for asthma, COPD and pneumonia
- Evidence for decreasing effect with increasing AC prevalence
- Increase in hospitalization of children from 6 to 12 for asthma related to coarse particulate exposure
- Stronger effects seen for ED visits

# PM and Respiratory Function



- Reduced peak expiratory flow observed in asthmatics on high PM days
- Among asthmatics, increased reporting of cough, phlegm and sore throat on high PM days
- Effects on reported symptoms more marked for asthmatic children than non-asthmatic children

# Other Endpoints of Concern

- Fetal and postnatal development and mortality
- Role of other pollutants hard to address:
  - Gaseous pollutants (ozone, CO)
  - Bioaerosols (pollen counts, fungal spores)
  - Meteorological variables
- Most PM is not diesel-derived



# Diesel Exhaust and Cancer

- Described as “likely to be carcinogenic to humans by inhalation” upon environmental exposure
- Based on observed relationship between occupational exposure to diesel exhaust and increased incidence of lung cancer
  - Professional drivers, railroad workers represented
- Observed mutagenicity suggests no threshold effect
  - Supportive of effects at environmental levels
  - Role of confounders not yet established

# Summary

- Diesel exhaust is complex
- DPM has been associated with acute and chronic health effects
- Reducing gaseous and particulate emissions will improve public health
- Health impact of new regulations is likely to be seen in several years' time